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विद्युत तकनीकी शब्दावली

भाग 38 पॉवर ट्रांसफार्मर तथा रिएक्टर

(दूसरा पुनरीक्षण)

Indian Standard

ELECTROTECHNICAL VOCABULARY

PART 38 POWER TRANSFORMERS AND REACTORS

(Second Revision)

UDC 621·314·222·6+621·318·43 : 001·4

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

May 1993 Price Group 7

Basic Electrotechnical Standards Sectional Committee, ET 01

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NATIONAL FOREWORD

This Indian Standard (Part 38) (Second Revision) which is identical with IEC Pub 50 (421) (1990) 'International electrotechnical vocabulary — Chapter 421 Power transformers and reactors', issued by the International Electrotechnical Commission (IEC), was adopted by the Bureau of Indian Standards on the recommendation of Basic Electrotechnical Standards Sectional Committee and approval of the Electrotechnical Division Council.

This Indian Standard (Part 38) was first published in 1973 and the first revision was done in 1977 and covered vocabulary relating to transformers only. This second revision has been undertaken to cover the vocabulary relating to both transformers and reactors and also to align it with the international practice.

Only the English text given in the IEC publication has been retained while adopting as Indian Standard, and as such the page numbers given here are not the same as in IEC publication.

IS 1885 (Part 38) : 1993
IEC Pub 50 (421) (1990)

Indian Standard
ELECTROTECHNICAL VOCABULARY
PART 38 POWER TRANSFORMERS AND REACTORS
(Second Revision)

SECTION 421-01 — GENERAL TERMS

421-01-01

power transformer

A static piece of apparatus with two or more windings which, by electromagnetic induction, transforms a system of alternating voltage and current into another system of voltage and current usually of different values and at the same frequency for the purpose of transmitting electrical power.

421-01-02

series reactor

A reactor intended for series connection in a network, either for limiting the current under fault conditions or for load-sharing in parallel circuits.

421-01-03

shunt reactor

A reactor intended for shunt connection in a network to compensate for capacitive current.

421-01-04

arc-suppression coil

A single phase neutral earthing reactor intended for compensating the capacitive line-to-earth current due to a single-phase earth fault.

421-01-05

three-phase earthing transformer

grounding transformer (USA)

A three-phase transformer intended for connection in a network without a neutral, to provide an artificial neutral.

421-01-06

three-phase neutral reactor

A three-phase reactor intended for connection in a network without a neutral to provide an aritficial neutral.

421-01-07

core-type transformer (deprecated)

A transformer in which the magentic circuit takes the form of columns (legs).

Notes.

1 — Generally, core-type transformers incorporate concentric windings.

2 — Since, there are types of transformer which do not come clearly within the categories of ''core-type'' and ''shell-type'', the use of these terms is deprecated. Generally they can be avoided by indicating the type of windings, i.e. ''concentric'' or ''sandwich'' and/or whether or not the magnetic circuit has unwound magnetic return paths.

421-01-08

core-type reactor (deprecated)

A reactor in which the magnetic circuit takes the form of columns (legs).

Note. — Since there are types of reactor which do not come clearly within the categories of ''core-type'' and ''shell-type '', the use of these terms is deprecated. Generally they can be avoided by indicating whether or not the magnetic circuit has unwound magnetic return paths.

421-01-09

shell-type transformer (deprecated)

A transformer where the packets of laminations forming the core and yokes surround the windings and enclose generally the major parts of them.

Notes.

1 — Generally, shell-type transformers incorporate sandwich windings.

2 — Since there are types of transformer which do not come clearly within the categories of "core-type" and "shell-type", the use of these terms is deprecated. Generally they can be avoided by indicating the type of windings, i.e. "concentric" or "sandwich" and/or whether or not the magnetic circuit has unwound magnetic return paths.

421-01-10

shell-type reactor (deprecated)

A reactor where the packets of laminations forming the core and yokes surround the windings and enclose generally the major part of them.

Note. — Since there are types of reactor which do not come clearly within the categories of "core-type" and "shell-type", the use of these terms is deprecated. Generally they can be avoided by indicating whether or not the magnetic circuit has unwound magnetic return paths.

421-01-11

auto-transformer

A transformer in which at least two windings have a common part.

421-01-12

booster transformer

series transformer (USA)

A transformer of which one winding is intended to be connected in series with a circuit in order to alter its voltage and the other winding is an energizing winding.

421-01-13

separate winding transformer

A transformer having windings with no common parts.

Note. — A separate winding transformer having two windings may be designated a "double wound transformer".

421-01-14

oil-immersed type transformer

A transformer of which the magnetic circuit and windings are immersed in oil.

421-01-15

oil-immersed type reactor

A reactor of which the magnetic circuit and windings are immersed in oil.

421-01-16

dry-type transformer

A transformer of which the magnetic circuit and windings are not immersed in an insulating liquid.

421-01-17

dry-type reactor

A reactor of which the magnetic circuit and winding are not immersed in an insulating liquid.

421-01-18

sealed transformer

A transformer which is non-breathing, that is, so sealed that there can be no significant interchange between its contents and the external atmosphere.

Notes.

1 — In the case of oil-immersed transformers, these may or may not have a cushion of air (or other gas).

2 — Sealed transformers fall into two categories:

a) transformers in which the total volume of oil, together with air (or other gas), or any combination thereof, remains constant over the temperature range.

b) transformers in which the total volume of oil, together with air (or other gas), or any combination thereof, varies over the temperature range and this variation is accommodated by a sealed flexible container or a flexible membrane.

421-01-19

sealed reactor

A reactor which is non-breathing, that is, so sealed that there can be no significant interchange between its contents and the external atmosphere.

Notes.

1 — In the case of oil-immersed reactors, these may or may not have a cushion of air (or other gas).

2 — Sealed reactors fall into two categories:

a) reactors in which the total volume of oil, together with air (or other gas), or any combination thereof, remains constant over the temperature range.

b) reactors in which the total volume of oil, air (or other gas), or any combination thereof, varies over the temperature range and this variation is accommodated by a sealed flexible container or flexible membrane.

421-01-20

encapsulated-winding dry-type transformer

A dry-type transformer having one or more windings encapsulated with solid insulation.

421-01-21

encapsulated winding dry-type reactor

A dry-type reactor having its winding encapsulated with solid insulation.

421-01-22

non-encapsulated-winding dry-type transformer

A dry-type transformer having none of the windings encapsulated with solid insulation.

421-01-23

non-encapsulated-winding dry-type reactor

A dry-type reactor having its winding non-encapsulated with solid insulation.

SECTION 421-02 — TERMINALS

421-02-01

line-terminal

A terminal intended for connection to a line conductor of a network.

421-02-02

neutral terminal

a) For polyphase transformers or reactors and polyphase banks of single-phase transformers or reactors:

The terminal(s) connected to the common point (the neutral point) of a star-connected or zigzag-connected winding.

b) For single-phase transformers or reactors:

The terminal intended for connection to a neutral point of a network.

421-02-03

corresponding terminals

Terminals of different windings of a transformer, marked with the same letter or corresponding symbol.

SECTION 421-03 — WINDINGS

421-03-01

winding

The assembly of turns forming an electric circuit associated with one of the voltages assigned to the transformer or to the reactor.

Note — For a polyphase transformer or polyphase reactor, the "winding" is the combination of the phase windings.

421-03-02

phase winding

The assembly of turns forming one phase of a polyphase winding.

Note — The term "phase winding" should not be used for identifying the assembly of coils on a specific leg.

421-03-03

high-voltage winding

The winding having the highest rated voltage.

421-03-04

low-voltage winding

The winding having the lowest rated voltage.

421-03-05

intermediate-voltage winding

A winding of a multi-winding transformer having a rated voltage intermediate between the highest and lowest winding rated voltages.

421-03-06

primary winding

A winding which, in service, receives active power from the supply network.

421-03-07

secondary winding

A winding which, in service, delivers active power to the load circuit.

421-03-08

auxiliary winding

A winding intended only for a small load compared with the rated power of the transformer.

421-03-09

stabilizing winding

A supplementary delta-connected winding, especially provided on star-star or star-zigzag connected transformers to decrease the zero-sequence impedance of the star-connected winding.

421-03-10

common winding

The common part of the winding of an auto-transformer.

421-03-11

series winding

The part of the winding of an auto-transformer or the winding of a booster transformer which is intended to be connected in series with a circuit.

421-03-12

energizing winding

The winding of a booster transformer which is intended to supply power to the series winding.

421-03-13

concentric windings

An arrangement where the windings or parts of windngs are arranged concentrically.

421-03-14

sandwich windings

An arrangement where the windings or parts of windings are arranged axially.

Note. — Normally the windings would be sub-divided.

SECTION 421-04 — RATING

421-04-01

rated voltage of a winding

The voltage assigned to be applied, or developed at no-load, between the line terminals of a winding of a polyphase transformer or reactor, or between the terminals of a winding of a single-phase transformer or reactor.

421-04-02

rated voltage ratio (of a transformer)

The ratio of the rated voltage of a winding to the rated voltage of another winding associated with a lower or equal rated voltage.

421-04-03

rated frequency

The frequency at which the transformer or reactor is designed to operate.

421-04-04

rated power

A conventional value of apparent power, establishing a basis for the design of a transformer, a shunt reactor or an arc-suppression coil, the manufacturer's guarantees and the tests, determining a value of the rated current that may be carried with rated voltage applied, under specified conditions.

Note. — Both windings of a two-winding transformer have the same rated power, which by definition is the rated power of the transformer. For multi-winding transformers the rated power for each of the windings may differ.

421-04-05

rated current

(of a winding of a transformer or shunt reactor)

The current, flowing through a line terminal of a winding, derived by dividing the rated power of the winding by the rated voltage of the winding and by an appropriate phase factor.

421-04-06

continuous rated current

a) of a series reactor:

The continuous current for which the reactor is designed.

b) of a three-phase neutral reactor or three-phase earthing transformer:

The continuous current in the neutral for which the equipment is designed when it is supplied at its rated voltage and frequency.

421-04-07

rated short-time current

a) of a series reactor or single phase neutral earthing reactor:

The fault current which the reactor is designed to carry for a specified duration.

b) of a three-phase neutral reactor or earthing transformer:

The current in the neutral which the apparatus is designed to carry for a specified duration.

421-04-08

rated current of an arc suppression coil

The current which the apparatus is designed to carry for a specified period when rated voltage is applied at rated frequency with the reactor arranged for maximum current.

SECTION 421-05 — TAPPINGS

421-05-01

tapping

tap

A connection made at some intermediate point in a winding.

421-05-02

principal tapping

The tapping to which the rated quantities are related.

421-05-03

tapping factor

The ratio U_d / U_N (tapping factor) or 100 U_d / U_N (tapping factor expressed as a percentage).

where:

U_N is the rated voltage of the winding

U_d is the voltage which would be developed at no-load at the terminals of the winding connected on the tapping concerned, by applying rated voltage to an untapped winding.

Note. — The tapping factor expresses the relative value of the "effective number of turns" of the tapped winding at the relevant tapping, the basis 1 being the effective number of turns of this winding at the principal tapping.

421-05-04

plus tapping

A tapping whose tapping factor is higher than 1.

421-05-05

minus tapping

A tapping whose tapping factor is lower than 1.

421-05-06

tapping step

The difference between the tapping factors, expressed as a percentage, of two adjacent tappings.

421-05-07

tapping range

The variation range of the tapping factor expressed as a percentage compared with the value "100".

Note. — If this factor ranges from 100 $+a$ to 100 $-b$, the tapping range is said to be $+a\%$ $-b\%$ or $\pm a\%$ if $a = b$.

421-05-08

tapping voltage ratio (of a pair of windings)

The ratio which is equal to the rated voltage ratio:

— multiplied by the tapping factor of the tapped winding if this is the high voltage winding.

— divided by the tapping factor of the tapped winding if this is the low voltage winding.

421-05-09

tapping duty

The numerical values assigned to the quantities (voltages, currents, etc.) which are used for a given tapping connection as a basis for the manufacturer's guarantees and, in the certain cases, for the tests.

421-05-10

tapping quantities

Those quantities the numerical values of which define the tapping duty. The tapping quantities include for each winding and for each tapping:

a) a tapping voltage,

b) a tapping power,

c) a tapping current.

Note. — Tapping quantities are related to a given tapping connection of the transformer and apply therefore to any winding, including any untapped winding.

421-05-11

tapping voltage of a winding

The voltage assigned to be applied or developed at no load between the line terminals of a winding of a polyphase transformer or between the terminals of a winding of a single phase transformer, for the relevant tapping of the transformer.

421-05-12

tapping power of a winding

A conventional value of apparent power, establishing for the relevant tapping connection of the transformer a basis for the manufacturer's guarantees and, in certain cases, for the test.

421-05-13

tapping current of a winding

The current flowing through a line terminal of a winding derived by dividing the tapping power of the winding by the tapping voltage of the winding and by an appropriate phase factor.

421-05-14

full-power tapping

A tapping whose tapping power is equal to the rated power.

421-05-15

reduced-power tapping

A tapping whose tapping power is lower than rated power.

SECTION 421-06 — LOSSES AND NO-LOAD CURRENT

421-06-01

no-load loss

The active power absorbed when a given voltage at rated frequency is applied to the terminals of one of the winding(s), the other winding being open circuited.

Note. — Normally the applied voltage is the rated voltage and the energised winding, if fitted with tappings, is connected on its principal tapping.

421-06-02

no-load current

The current flowing through a line terminal of a winding when a given voltage is applied at rated frequency the other winding(s) being open-circuited.

Notes.

1 — Normally the applied voltage is the rated voltage and the energized winding, if fitted with tappings, is connected on its principal tapping.

2 — The no-load current of a winding is often expressed as a percentage of the rated current of the same winding.

421-06-03

load loss

a) of two-winding transformers (for the principal tapping):

The active power absorbed at rated frequency when rated current is flowing through the line terminal(s) of one of the windings, the terminals of the other winding being short-circuited, and any winding fitted with tapping being connected on its principal tapping.

b) of multi-winding transformers, related to a certain pair of windings (for the principal tapping):

The active power absorbed at rated frequency when a current flows through the line terminal(s) of one of the windings of the pair, corresponding to the smaller of the rated power values of both windings of that pair, the terminals of the other winding of the same pair being short-circuited, any winding of the pair fitted with tappings being connected on its prinicipal tapping and the remaining winding(s) being open-circuited.

Notes.

1 — The load loss can also be considered for tappings other than the principal tapping. The reference current of two-winding transformers is, for any tapping, equal to the tapping current. For multi-winding transformers, the reference current or reference power are related to a specified loading combination.

2 — The load loss is normally related to the appropriate reference temperature.

421-06-04

supplementary load loss

The loss figure given by subtracting the I^2R loss (corrected to the appropriate reference temperature) from the load loss.

Note. – R is equal to the d.c. resistance.

421-06-05

total losses

The sum of the no-load loss and the load loss.

Note. – For multi-winding transformers, the total losses refer to a specified loading combination.

SECTION 421-07 — IMPEDANCE VOLTAGE, SHORT-CIRCUIT IMPEDANCE AND VOLTAGE DROP

421-07-01

impedance voltage at rated current (for the principal tapping)

a) of two-winding transformers:

The voltage required to be applied at rated frequency to the line terminals of a winding of a polyphase transformer, or to the terminals of a winding of a single-phase transformer, to cause the rated current to flow through these terminals when the terminals of the other winding are short-circuited.

Note. — The value is normally related to the appropriate reference temperature.

b) of multi-winding transformers, related to a certain pair of windings:

The voltage required to be applied at rated frequency to the line terminals of one of the windings of a pair for a polyphase transformer, or to the terminals of such a winding for a single-phase transformer, to cause a current to flow through these terminals corresponding to the smaller of the rated power values of both windings of that pair, the terminals of the other winding of the pair being short-circuited and the remaining winding(s) being open-circuited.

Notes.

1 — The various values for the different pairs are normally related to the appropriate reference temperature.

2 — The impedance voltage at rated current is usually expressed as a percentage of the rated voltage of the winding to which the voltage is applied.

421-07-02

short-circuit impedance of a pair of windings

The equivalent star connection impedance related to one of the windings, for a given tapping and expressed in ohms per phase, at rated frequency, measured between the terminals of a winding when the other winding is short-circuited.

Note. — This value is normally related to the appropriate reference temperature.

421-07-03

voltage drop or rise for a specified load condition
voltage regulation for a specified load condition

The arithmetic difference between the no-load voltage of a winding and the voltage developed at the terminals of the same winding at a specified load and power factor, the voltage supplied to (one of) the other winding(s) being equal to:

- its rated value if the transformer is connected on the principal tapping (the no-load voltage of the former winding is then equal to its rated value);
- the tapping voltage if the transformer is connected on another tapping.

This difference is generally expressed as a percentage of no-load voltage of the former winding.

Note. — For multi-winding transformers, the voltage drop or rise depends not only on the load and power factor of the winding itself but also on the load and power factor of the other windings.

421-07-04

zero-sequence impedance (of a polyphase winding)

The impedance, expressed in ohms per phase at rated frequency, between the line terminals of a polyphase star or zigzag-connected winding connected together and its neural terminals.

SECTION 421-08 — TEMPERATURE RISE

421-08-01

temperature rise

The difference between the temperature of the part under consideration and the temperature of the cooling air or of the water at the intake of the cooling equipment, for air-cooled or water-cooled transformers or reactors respectively.

SECTION 421-09 — INSULATION

421-09-01

highest voltage for equipment U_m (applicable to a transformer or reactor winding)

The highest r.m.s. phase-to-phase voltage for which a transformer or reactor winding is designed in respect of its insulation.

Note. — U_m is the maximum value of the highest voltage of a system to which the winding may be connected, in respect of its insulation.

421-09-02

rated insulation level

The test voltages, under specified conditions, that the insulation is designed to withstand.

Note. — These test voltages can be for instance:

a) rated lightning impulse and short duration power frequency withstand voltages.

b) rated lightning and switching impulse withstand voltages (phase-to-earth).

421-09-03

uniform insulation of a winding (of a transformer or of a reactor)

The insulation of the winding of a transformer or of a reactor when all its ends connected to terminals have the same power frequency withstand voltage to earth.

421-09-04

non-uniform insulation of a winding (of a transformer or of a reactor)

The insulation of the winding of a transformer or of a reactor when it has an end intended for direct or indirect connection to earth and is designed with a lower insulation level assigned to this earth or neutral winding end.

SECTION 421-10 — CONNECTIONS

421-10-01

star connection

Y connection (USA)

wye connection (USA)

The winding connection so arranged that one end of each of the phase windings of a polyphase transformer or reactor, or of each of the windings for the same rated voltage of single-phase transformers or reactors associated in a polyphase bank, is connected to a common point, i.e. the neutral point, and the other end to its appropriate line terminal.

421-10-02

delta connection

The winding connection so arranged that the phase windings of a three-phase transformer or reactor, or the windings for the same rated voltage of single-phase transformers or reactors associated in a three-phase bank, are connected in series to form a closed circuit.

421-10-03

open-delta connection

The winding connection in which the phase windings of a three-phase transformer, or the windings for the same rated voltage of single-phase transformers associated in a three-phase bank, are connected in series without closing one corner of the delta.

421-10-04

zigzag connection

The winding connection in which one end of each phase winding of a polyphase transformer or reactor is connected to a common point, i.e. the neutral point, and each phase winding consists of two parts in which phase-displaced voltages are induced.

Note. — These two parts normally have the same number of turns.

421-10-05

open windings

Phase windings of a polyphase transformer or reactor which are not interconnected within the transformer or the reactor.

421-10-06

Scott connection

A method of interconnecting the windings of two single-phase transformers for the transformation of three-phase voltages to two-phase voltages or vice versa.

421-10-07

Leblanc connection

A method of connecting the windings of a three-phase transformer for the transformation of three-phase voltages to two-phase voltages or vice versa.

421-10-08

phase displacement

phase difference (for a transformer)

The angular difference between the phasors representing the voltages between the neutral point (real or imaginary) and the corresponding terminals of two windings, a positive-sequence voltage system being applied to the high voltage terminals, following each other in alphabetical sequence if they are lettered, or in numerical sequence if they are numbered. The phasors are assumed to rotate in a counter-clockwise sense.

421-10-09

connection symbol

A conventional notation indicating the connections of the high-voltage, intermediate-voltage (if any) and low-voltage windings and their relative phase displacement(s) expressed as a combination of letters and clock-hour figure(s).

SECTION 421-11 — ON-LOAD TAP-CHANGERS

421-11-01

on-load tap-changers

load-tap-changer (USA)

A device for changing the tapping connections of a winding, suitable for operation while the transformer is energized or on load.

421-11-02

tap selector

A device designed to carry, but not to make or break current, used in conjunction with a diverter switch to select tapping connections.

421-11-03

diverter switch

A switching device used in conjunction with a tap selector to carry, make and break current(s) in circuits which have already been selected.

421-11-04

selector switch

A switching device capable of making, carrying and breaking current, combining the duties of a tap selector and a diverter switch.

421-11-05

change-over selector

A device designed to carry, but not to make or break, current, used in connection with a tap selector or selector switch to enable its contacts and the connected tappings to be used more than once when moving from one extreme position to the other.

421-11-06

transition impedance

A resistor or reactor consisting of one or more units bridging the tapping in use and the tapping next to be used, for the purpose of transferring load from one tapping to the other without interruption or appreciable change in the load current, at the same time limiting the circulating current for the period that both tappings are used.

421-11-07

driving mechanism

The means by which the drive to the tap-changer is actuated.

421-11-08

set of contacts

A pair of individual fixed and moving contacts or combination of pairs operating substantially simultaneously.

421-11-09

main contacts

Any set of through-current carrying contacts which has no transition impedance fitted in circuit between the transformer winding and the contacts and which does not switch any current.

421-11-10

main switching contacts

Any set of contacts which has no transition impedance fitted in circuit between the transformer winding and the contacts and breaks the current.

421-11-11

transition contacts

Any set of contacts where a transition impedance is in series with the transformer windings and the contacts.

421-11-12

circulating current

That part of the current which flows through the transition impedance at the time when two tappings are bridged during a tap-change operation and which is due to the voltage difference between the tappings.

421-11-13

switched current

The prospective current to be broken during switching operation by each set of main switching or transition contacts incorporated in the diverter switch or selector switch.

421-11-14

recovery voltage

The power frequency voltage which appears across each set of main switching or transition contacts of the diverter switch or selector switch after these contacts have broken the switched current.

421-11-15

tap-change operation

The complete sequence of events from the initiation to the completion of the transition of the through-current from one tap of the winding to an adjacent one.

421-11-16

cycle of operation

The movement of the tap-changer from one end of its range to the other and the return to its original position.

421-11-17

rated through-current

The current flowing through the tap-changer towards the external circuit, which the apparatus is capable of transferring from one tapping to the other at the relevant rated step voltage and which can be carried continuously.

421-11-18

maximum rated through-current

The rated through-current for which both the temperature rise of the contacts and the service duty test apply.

421-11-19

rated step voltage

For each value of rated through-current, the highest permissible voltage between terminals which are intended to be connected to successive tappings of transformer.

421-11-20

maximum rated step voltage

The highest value of the rated step voltage for which the tap changer is designed.

421-11-21

number of inherent tapping positions

The highest number of tapping positions for half a cycle of operation for which tap-changer can be used according to its design.

421-11-22

number of service tapping positions

The number of tapping positions for half a cycle of operation for which a tap-changer is used in a transformer.

Note. – When using the term "number of tapping positions" in connection with a transformer, this always refers to the number of service tapping positions of the tap-changer.

SECTION 421-12 — ON-LOAD TAP-CHANGER MOTOR-DRIVE MECHANISMS

421-12-01

motor-drive mechanism

A drive mechanism which incorporates an electric motor and control circuit.

421-12-02

step-by-step control

Electrical and mechanical devices stopping the motor drive mechanism after completion of a tap change independently of the operating sequence of the control switch.

421-12-03

tap position indicator

An electrical, mechanical or electromechanical device for indicating the tap position of the tap-changer.

421-12-04

tap-change in progress indicator

A device indicating that the motor-drive mechanism is operating.

421-12-05

limit switch

An electomechanical device preventing operation of the tap-changer beyond an end position but allowing operation towards the opposite direction.

421-12-06

mechanical end stop

A device which physically prevents operation of tap-changer beyond either end position but allows operation towards opposite direction.

421-12-07

parallel control devices

Electrical control devices to move, in the case of parallel operation of several transformers with tappings, all tap-changers to the required position and to avoid divergence of the respective motor-drive mechanisms.

421-12-08

emergency tripping device

An electrical, mechanical, or electromechanical device for stopping the motor-drive mechanism at any time in such a way that a special action has to be performed before the next tap-change operation can be started.

421-12-09

overcurrent blocking device

An electrical device preventing or interrupting operation of the motor-drive mechanism for the period in which an overcurrent exceeding a preset value is flowing in the trasformer winding.

421-12-10

operation counter

A device indicating the number of the tap-changes accomplished.

421-12-11

manual operation of motor-drive mechanism

Operation of the tap-changer manually by a mechanical device, blocking at the same time operation by the electric motor.

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Amendments Issued Since Publication

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Printed at New India Printing Press, Khurja, India